Job Loss Analysis

Control No: **Status:** **Original Date 8/24/2011**
Last Date Closed:

Organization: Sulfur and Tail Gas Treating BIN
JLA Type: Global Mfg – Refining
Work Type: Technical (Process Engineering)
Work Activity: SRU Claus Conversion Efficiency

Personal Protective Equipment (PPE)

☐ Goggles	☒ Hearing Protection	☐ Safety Cones/Barrier	☐ Welding Hood
☒ Face Shield	☒ Hard Hat	☐ Tagout/Lockout	☐ Gloves(Kevlar, rubber, leather)
☒ Safety Glasses	☒ Safety Boots	☐ Hi Viz Jacket	☐ Other ie. Alky PPE.________________
☒ H2S Monitor	☒ Fire Resistant Clothing	☐ Long Pants/Trousers	
		☐ Long Sleeve shirt	

Reviewers

Reviewer Name	Position	Date Approved
Jay Davis	Sulfur and Tail Gas Treating BIN Leader	8/24/2011

Development Team

Development Team Member Name	Primary Contact	Position
Sulfur and Tail Gas Treating BIN Team	CTN 938-4967	Process Engineering and Sulfur Plant Operations

Job Steps

No.	Job Steps	Potential Hazard	Critical Action
1	Review operation of tail gas analyzer	1. Extra air input will lead to excess SO2 in tail gas and potential hydrogenation temperature excursion. In addition, loss of sulfur conversion can lead to excess sulfur load on tail gas unit which could result in excess energy consumption and environmental deviations.	1a. Check pressure and temperature compensation of all feeds to main reaction furnace (air, acid gas, natural gas, oxygen, and sour water stripper gas). 1b. Check air blower operation. Check anti-surge control is not swinging. 1c. Ensure ADA (air demand analyzer) tail gas ratio control is in automatic control. If not, determine reason for manual operation. 1d. Check ADA tail gas ratio set point is at desired value (2 H2S : 1 SO2 is maximum conversion). 1e. Ensure control valves are operating properly and not sluggish or sticking.

			1f. Check that all burner instrumentation and controller tuning is working correctly.
2	Review Claus catalyst condition	1. Loss of catalyst life will lead to loss of conversion and potential environmental deviation. 2. Potential for H2S exposure or sulfur splashing when checking sultrap or look-box flows.	1a. Check for decline in Claus conversion by trending H2S+SO2 from ADA output. 1b. Check bed catalyst temperature profile to determine if temperature rise has changed significantly from expected. 1c. Check bed catalyst temperature profiles for shift of reaction to bottom of bed or downstream Claus beds. 1d. Check bed catalyst temperature profile for flow channeling. 1e. Check catalyst dew point margin is at desired value (typically 10-20F). 1f. Perform heatsoak/rejuvenation to recover loss Claus conversion. 2a. Ensure proper PPE worn when opening sultrap. 2b. Ensure sultrap is isolated before opening. 2c. Ensure personal H2S monitor is calibrated and in good working condition. 2d. Ensure sultrap lid or look-box opening is pointed away from operator when opening.
		3. Catalyst could be sooted from firing on natural gas during startup or shutdown.	3a. Check dip-legs or sultraps for gray or discolored sulfur. 3b. Check for increased pressure at reaction furnace, change in capacity factor, or increased bed pressure drop. 3c. Ensure natural gas valves are positively isolated and not leaking into process. 3d. Ensure natural gas flow meters are properly calibrated for hot strip or heat up operation. 3e. Ensure natural gas and air flow meters to burners are pressure and temperature compensated.
		4. Declining catalyst or equipment condition or design could cause loss of conversion.	4a. Ensure titania catalyst ratio is properly designed for COS/CS2 destruction. 4b. Ensure catalyst reactor integrity in intact and not losing catalyst around screen edges.

3	Review operation of sulfur condensers	1. Condenser plugging can result in high front end pressure and possible sulfur back-flowing into auxiliary burners eventually resulting in shut down, LPO, and potential environmental deviation. In addition, loss of sulfur conversion can lead to excess sulfur load on tail gas unit which could result in excess energy consumption and environmental deviations. 2. Exercise caution when draining condensate from heating systems to walking surfaces. 3. Potential for H2S exposure or sulfur splashing when checking sultrap or look-box flows.	1a. Check sultraps/sulfur seals for normal production of sulfur. 1b. Check sultrap baskets and remove any solids. Check condition of sultrap float. Float may be stuck, damaged, or sink in sulfur. 1c. For sulfur seals, check jacketed piping to ensure hot and check screens for particulates. 1d. Conduct pressure survey around condensers to indentify plugging location. 1e. Consider increasing condenser temperature by increasing bed inlet temperature. 1f. Steam back through udder to remove plug from demister pad. 1g. Ensure demister steam coil is in service. • Check steam trap on demister steam coil. • Consider dumping condensate to the pad (using all safety precautions) and introduce steam through the shell side to heat tubes. 1h. Ammonia salts tend to plug condensers or demister pads. These can form due to poor burner operation (O2 slip), after shutdown/startup, low turndowns, poor upstream/feed source operations. • Consider adding natural gas or lowering air/gas ratio on reheater if ammonia salts are forming. • Consider increasing liquid oxygen to main reaction furnace to increase temperature and to increase conversion of ammonia. 1i. A BFW / steam leak will result in water in the sulfur which can be seen in the look-box. 1j. Check look-box for quality of sulfur – if water present. 1k. Check view ports for water droplets. 2a. Ensure proper PPE worn when draining condensate. 2b. Ensure condensate cannot collect in low spots to form puddles that can be stepped into. 2c. Ensure condensate is drained to sewer and does not form slipping hazard. 2d. Ensure condensate is collected following steam-out.

			3a. Ensure proper PPE worn when opening sultrap. 3b. Ensure sultrap is isolated before opening. 3c. Ensure personal H2S monitor is calibrated and in good working condition. 3d. Ensure sultrap lid or look-box opening is pointed away from operator when opening.
4	Check pressure in main reaction furnace for indication of Claus section restriction.	1. Claus plant can trip on high pressure in main reaction furnace. As pressure builds on Claus section, it will prevent feed from entering system or cause control valves to operate closer to fully open.	1a. Check flow of sultraps or sulfur seals. Determine if this is normal flow for front end feed rate. 1b. Check for indications of ammonia salts in the demisters. May require steam on shell side to raise temperature to melt plug in condenser. Check for gray or green sulfur on sultrap float or clinkers in baskets or look-boxes. 1c. Conduct pressure survey to identify point of high pressure drop. 1d. Check for appropriate steam feed rates to the main reaction furnace.
5	Review operation of all Claus section burners.	1. Oxygen breakthrough from burner will lead to catalyst sulfation and loss of Claus conversion. Improper ratio in main reaction furnace and fired reheaters will lead to loss of Claus conversion. 2. Refractory damage can cause excessive corrosion in burner fireboxes. 3. Burner tip plugging or corrosion can cause excessive oxygen breakthrough.	1a. Visually check burner flames for abnormal appearance. 1b. Check controller outputs to indentify abnormal operation. 1c. Ensure that instrumentation is reading correctly. 1d. Check pressure and temperature compensation calculation – verify in field on transmitters and on the distributed control system. 2a. Assess LPO or add to shutdown list. 2b. Perform infrared analysis of external shell to determine extent of corrosion. 3a. Steam out burner tip if plugged. 3b. PMI burner tips, barrels, etc. during shutdown to verify correct metallurgy. 3c. Investigate use of ceramic coated burner tips with BIN leadership.
6	Check for changes in feed or special events.	1. When operating in turndown condition,	1a. Sooting of catalyst possible from operating below design rates.

		Claus conversion efficiency can be affected.	1b. Verify flow rates for burner control are above the minimum required flows based upon the burner design and the plant design conditions. (i.e. air flows, nitrogen as needed for burner protection, natural gas, SWAG, H2S flow)
			• Flows and process feedback parameters are not flat-lining.
			• Verify sulfur still flowing in seals / sultraps.
			
			1c. Equipment damage caused by insufficient flow for cooling protection of equipment (i.e. Burner face overheating due to flame impingement)
			• Verify flow rates for burner control are above the minimum required flows based upon the burner design and the plant design conditions. (i.e. air flows, nitrogen as needed for burner protection, natural gas, SWAG, H2S flow)
			  ○ SIS System Protections Armed and properly working (i.e. flame scanners armed and working etc)
			  ○ Monitor last condenser temperature outlet to prevent sulfur freezing/plugging
			    ▪ Increase last reactor inlet temperature.
			    ▪ Temperature of BFW may impact boilers during turndown condition (i.e. poor boiler level control, steam production, changing condensing such as during tray flooding
			  ○ Verify sulfur still flowing in sulfur seals / sultraps
			
			1d. Low flow conditions can impact sulfur condensing too much by creating a sulfur fog that will carry-over to the next reactor or tail gas unit thereby reducing Claus conversion. Calculate mass velocity through condenser tubes to ensure fogging conditions are avoided.

		2. Feed composition changes may reduce Claus conversion efficiency.	2a. Excessive ammonia, hydrocarbon, CO2, or H2O in feed:
			• Plugging of Equipment:
			  ○ Verify sulfur still flowing in seals / sultraps.
			  ○ Monitor pressure profile or plant capacity factor.
			  ○ Verify proper temperature, time, and turbulence for ammonia destruction.
			  ○ Flows and process feedback parameters are not flat-lining.
			  ○ Verify ammonia percentage is not too high for a given plant design.
			  ○ H2S or SO2 breakthrough:
			    ▪ Verify proper temperature, time, and turbulence for ammonia destruction.
			    ▪ Flows and process feedback parameters are not flat-lining.

			▪ Check ADA and ADA setpoint for proper operating conditions. ▪ Verify TGU Operation such as for the H2S recycle or the SO2 recycle stream. ▪ SIS System Protections Armed and properly working (i.e. flame scanners armed and working etc). o Reduced throughput ▪ Verify sulfur still flowing in seals / sultraps. ▪ Monitor pressure profile of plant main reaction furnace >> Claus reactor. ▪ Flows and process feedback parameters are not flat-lining. ▪ Check ADA and ADA setpoint for proper operating conditions. ▪ Verify proper operation of fired auxiliary burners. • Excessive water and CO2 will reduce main reaction furnace temperature and cause loss of Claus conversion: o For water, check for higher temperatures than normal of the acid gas from amine regenerator, sour water stripper, or WWT H2S stripper. o For CO2, check for change in refinery units such as the FCC being a higher percentage of the acid gas feed or change in operation of the LPG treaters.
		3. Intended and unintended modifications during turnaround can reduce Claus conversion efficiency.	3a. Changes not Communicated to affected plant operators: • Operators may not complete proper moves for a given situation at the wrong time and/or not complete necessary task(s). o Lack of fully qualified operators for given task(s). o Unfamiliarity of equipment and procedures. o Lack of training on modifications made during turnaround. 3b. Work Scope Changed - Not Accurate: • Operators may not complete proper moves for a given situation at the wrong time and/or not complete necessary task(s). • Equipment or wrong equipment cleaned. • Equipment damaged that is needed for necessary clean-up and/or isolation of related equipment that is in the work scope. 3c. MOC Process Not Followed: • Operators may not complete proper moves for a given situation at the wrong time and/or not complete necessary task(s) for the given MOC

			related change. • Isolation of associated equipment for MOC work. • Equipment or wrong equipment cleaned. • Equipment damaged that is needed for necessary clean-up and/or isolation of related equipment that is in the MOC work scope. • Modifications made that were not properly vetted with the appropriate subject matter experts.
		4. Main reaction furnace temperature change from normal could indicate loss of Claus conversion.	4a. Temperature in main reaction furnace too high: • Verify temperature is suitable for the given main reaction furnace refractory design and skin temperatures. • Hydrocarbon contamination in feed stream will affect conversion. • Hydrocarbon contamination will consume oxygen and cause tail gas ratio to swing or operate above desired setpoint. 4b. Temperature in main reaction furnace too low: • Incomplete conversion of ammonia/SWAG, if feeding. • CO2 is a higher percentage of the feed than normal. • Feed contains more water than normal due to high upstream regenerator temperature. • Incomplete destruction of hydrocarbons leading to formation of excessive COS/CS2. • Improper ratio of air to acid gas will cause reaction furnace temperature to drop (common at start-up when ADA is out of service). • Hydrocarbon contamination in feed stream could lead to carsul formation on catalyst restricting active sites for conversion. • Incomplete combustion possibly producing sooting particulates that accumulates on catalyst beds. • Verify purges on thermocouples. May show false indication if purge too high. • Delta Controls ceramic temperature indicators will start to diverge when damaged and both will eventually fail. • Sulfur backflow from first condenser causing flashing of molten sulfur in WHB tubes and lowering reaction furnace temperature. Check condenser, sulfur seal or sultrap for plugging.
		5. Steam reheater leaks will cause Claus conversion decrease.	5a. High pressure in Claus train causing a shut down or increased back pressure on main reaction furnace: • Verify normal sulfur flow in seals / sultraps. • Verify plant pressure profile is normal for current feed rate.

		6. Potential to expose personnel to high pressure steam leaks from damaged equipment.	• Monitor steam flows into the reheater and condensate flow from reheater.
			• Equipment damage elevating as problem not fixed:
			  ○ Verify that the steam source causing the leak is not inadvertently coming from another piece of equipment.
			  ○ Schedule a plant shutdown or a slowdown as operations warrant as soon as possible to repair damaged equipment.
			  ○ Increased sour water production from quench column / CCD.
			6a. Notify plant operators and associated personnel of the hazards.
			
			6b. Remove any non-essential personnel from the area.
			
			6c. Ensure condensate cannot collect in low spots to form puddles that can be stepped into.
			
			6d. Ensure condensate is drained to sewer and does not form slipping hazard.

7	Review heat soak / rejuvenation conditions to ensure performed correctly.	1. Incorrect temperatures could result in insufficient heat soak (too low temps) or if left too high would reduce Claus recovery and load up tail gas unit. If rejuvenation is not preformed correctly (not on high H2S side but high on SO2 side), could have insufficient rejuvenation or increase sulfates on catalyst (if operate less than 2:1).	1a. Verify procedures are adequate and correct. Consult Best Practices recommendations. 1b. Ensure operators are adequately trained. 1c. If no benefit is seen from heat soak / rejuvenation, assess value. Catalyst may be near end of life. 1d. Ensure tail gas unit is not overloaded from additional sulfur load from heat soak and rejuvenation.
8	Review steam trap operation	1. Sulfur plugging causing high back pressure, loss of unit, shutdown, plugging of catalyst beds, H2S/SO2 release to pit. 2. Too much back pressure on condensate system which can cause	1a. Check steam traps by melting sulfur on trap / piping to see if it is hot enough to melt sulfur. 1b. If trap is found that is cold it will be necessary to open trap to atmosphere and bleed condensate to ground until trap is repaired. 1c. Write work-order to repair. 2a. Check pressure upstream of steam traps and downstream to see if there is adequate differential pressure to remove condensate from traps.

		hammering in condensate system if other traps are failed open.	
9	Review need for extensive testing by outside experts.	1. Potential exposure to high H2S streams during performance testing.	1a. Determine what streams need to be sampled and which outside company can accurately analyze those streams: • Brimstone • Sulphur Experts • Sulfur Recovery Engineers • Chevron ETC 1b. Discuss testing cost estimate with local management before scheduling testers. 1c. Ensure all samples points are clean and unplugged prior to arrival of testing company. Install Strahman valves next turnaround if needed to ensure integrity of sample point and sample testing. 1d. Discuss sample locations with operations and determine when back-up SCBA is needed. 1e. Ensure plant to be tested has been in steady operation without feed rate change for at least 4 hours before testing. 1f. Ensure preliminary sample data is available from testers. 1g. Ensure final performance report is received in a timely manner.